when does Sound become Noise ?

Installation guide to low noise refrigeration

Prepared by:

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Sound, Noise and Refrigeration Equipment

Sound is vital in everyday life for communication, safety and enjoyment. Noise is usually defined as unwanted sound, and this includes noise from mechanical plant such as refrigeration equipment, air conditioners, pumps and various other items of equipment.

The type and location of equipment can influence the noise impact and annoyance to owners, adjacent properties and neighbours.

This brochure is a guide to some of the DO's and DON'T's and helps explain the noise impact of refrigeration equipment installations. This brochure is a guide only and advice should be sought from a qualified acoustic consultant for more detailed advice and assessments.

Noise Limits and Regulations

The acceptable or allowable noise limits from refrigeration and other equipment from one property to a neighbouring property is generally enforced by local councils or police based on State or Territory legislation. The Reference List at the end of this brochure is a starting point for identifying the appropriate noise legislation for each State and Territory.

The guideline limits may depend on the zoning of the surrounding area, whether the noise is intermittent or tonal, time of day etc. A typical requirement is that the equipment noise should not exceed the background noise by more than 5 dBA. In most cases nuisance and annoyance may be avoided if a noise goal of 35 to 40 dBA at the boundary is achieved.

Item	Typical Sound Pressure Level (dBA)	Subjective Evaluation
Threshold of Pain	130	Intolerable
Heavy Rock Concert / Grinding on Steel / Ambulance Sirens / Chainsaw	110 - 120	Extremely Noisy
Loud Car Horn / Jackhammer / Construction Site with Pnematic Hammering	90 - 100	Very Noisy
Curbside of a Busy Street / Loud Radio or TV / Lawn Mower / Electric Drill	70 - 80	Loud
Normal Conversation / Department Store / General Office	50 - 60	Moderate to Quiet
Inside a Private Office / Inside a Quiet House	30 - 40	Quiet to Very Quiet
Unoccupied Recording Studio / Quiet Day in the Country	20	Almost Silent
Threshold of Hearing	0	Completely Silent

Measurement of Sound - the dBA

The human ear responds to changes in sound pressure over a very wide range. The loudest sound pressure which the ear responds to is ten million times greater than the softest. In order to simplify and reduce such a large range, a logarithmic scale, called the decibel, or dBA is used.

The human ear also responds differently to the frequency of sound. For example, the human ear is more sensitive at mid frequencies (500 to 1000 Hz), and less sensitive at very high and very low frequencies, hence, sound level meters incorporate a filter which approximately corresponds to that of human hearing. This filter is the 'A-Weighted' filter.

So the 'dBA' or 'dB(A)' is the A-Weighted sound level in decibels. This is the most commonly used measurement parameter for sound.

Sound Pressure Level (SPL) and Sound Power Level (SWL)

Refrigeration equipment and items of plant sometimes have a label displaying the total Sound Power Level (referred to as SWL or Lw), or the Sound Pressure Level (referred to as SPL or Lp), in dBA. If the equipment does not have a label indicating the noise level then the supplier should be able to provide this data.

The SPL or SWL indicate how noisy the equipment is, the lower the number, the quieter the equipment.

The SWL is a measure of how much acoustic power is produced by the equipment. The SPL is the resulting noise level from the operation of the equipment. The SPL depends on the location of the sound source, how many reflecting surfaces are nearby (how reverberant the space is) and the distance between the equipment and the receiver.

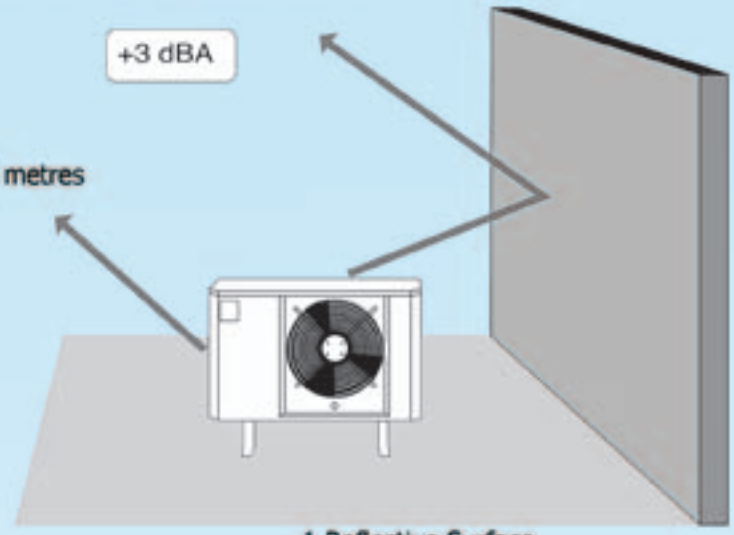
The SWL is an intrinsic property of the equipment where as the SPL depends on the SWL and the environment. For example, the SWL maybe thought of as the Watts of a light bulb, while the SPL is similar to the overall brightness - it depends on the environment (e.g. size of room, colour of walls) as well as the power of the light bulb.

Generally, the SPL is lower than the SWL. In a 'Free Field' with no reflecting surfaces such as walls nearby, the SPL is approximately 8 dBA lower than the SWL at one metre from the equipment (assuming source is on a hard surface).

Reduction of Sound Pressure Level (SPL)									
Distance (m)	1	2	3	4	5	6	7	8	10
Reduction (dBA)	8	14	17	20	22	23	25	26	28

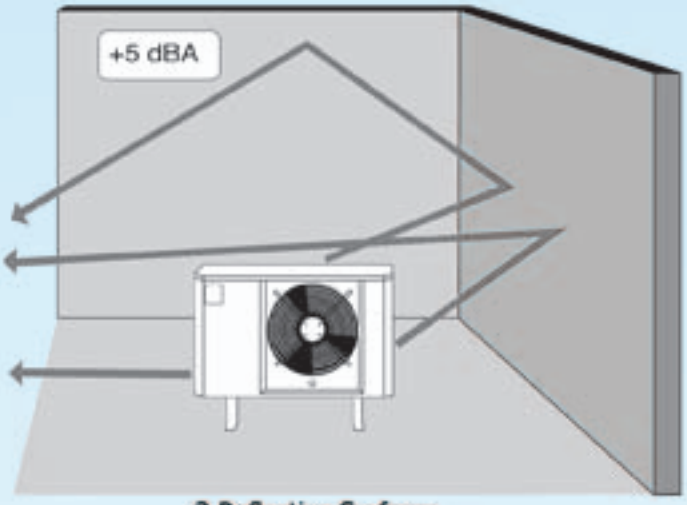
Sound Pressure Level and Reflective Surfaces

Reflective surfaces such as walls or a ceiling near the noise source can increase the resulting Sound Pressure Level (SPL). The following diagrams illustrate the effect of reflective surfaces.



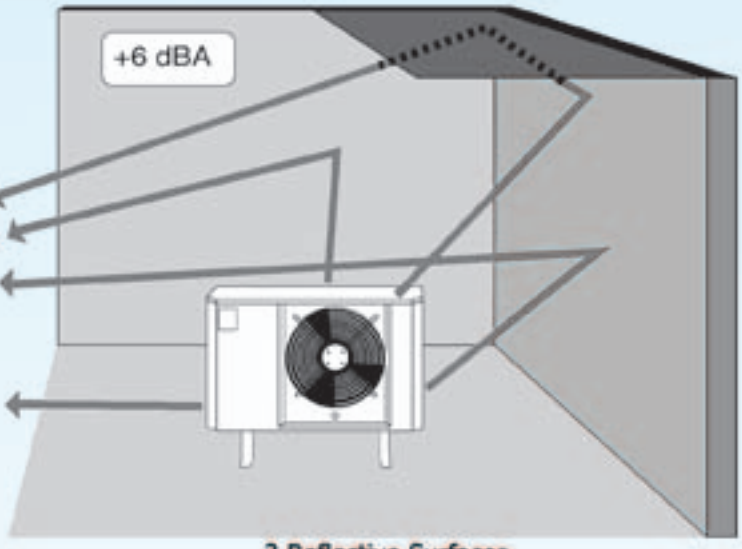
+3 dBA if unit is within 3 metres of 1 wall/ceiling

1 Reflective Surface



+5 dBA if unit is within 3 metres of 2 walls/ceiling

2 Reflective Surfaces



+6 dBA if unit is within 3 metres of 3 walls/ceiling

3 Reflective Surfaces

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Addition of dB Levels

The decibel scale is a logarithmic scale so 2 + 2 does not equal 4. A doubling of the sound pressure levels results in an increase of 3 dBA. The following table shows the result of adding two SPL's or SWL's together. The first column shows the difference between the two SPL's and the second column shows resulting dBA increase - the level that should be added to the higher of the two SPL's to obtain your result.

Example: Two units both at 50 dBA. The difference is zero, so 3 dBA is added to the noisier unit (either one in this case) to give an overall noise level of 53 dBA.

Example: One unit is 50 dBA, the other is 46 dBA. The difference is 4 dBA - the table says you should add 1.5 dBA to the noiser unit - so the overall level is 51.5 dBA.

As you can see, because the addition of dBA levels is logarithmic, the level may not increase very much but it is always controlled by the noisier item of equipment - the best approach is to use the quietest equipment possible to begin with!

Difference between SPL's (dB)	Result - amount to add to the higher SPL
0	3
1	2.5
2	2.1
3	1.8
4	1.5
5	1.2
6	1
7	0.8
8	0.6
9	0.5
10	0.4

Vibration

Vibration from plant and equipment may result in regenerated noise and you could end up with more noise than you expected. In addition, the vibration may adversely affect the owner / user of the equipment. The vibration from the equipment may be transmitted through various support structures and end up in a lightweight structure which could radiate noise.

The following provides some guidence with regard to vibration control:

- Use at least 1 layer of waffle pad, not less than 8mm thick, under equipment in all areas

- Ensure that the waffle pad is not bypassed by a rigid connection. The units should be sitting on the waffle pad under their own weight, not bolted to the structure through the pad. If the unit must be bolted then ensure that a rubber isolating washer and sleeve is used.

- Install equipment on a concrete slab at ground level if possible

- Install equipment on a platform above lightweight structures if possible

- Do not locate equipment above particularly sensitive spaces (e.g. bedrooms or private offices in commercial situations), also try to keep the equipment as far away as possible from all adjacent receivers.

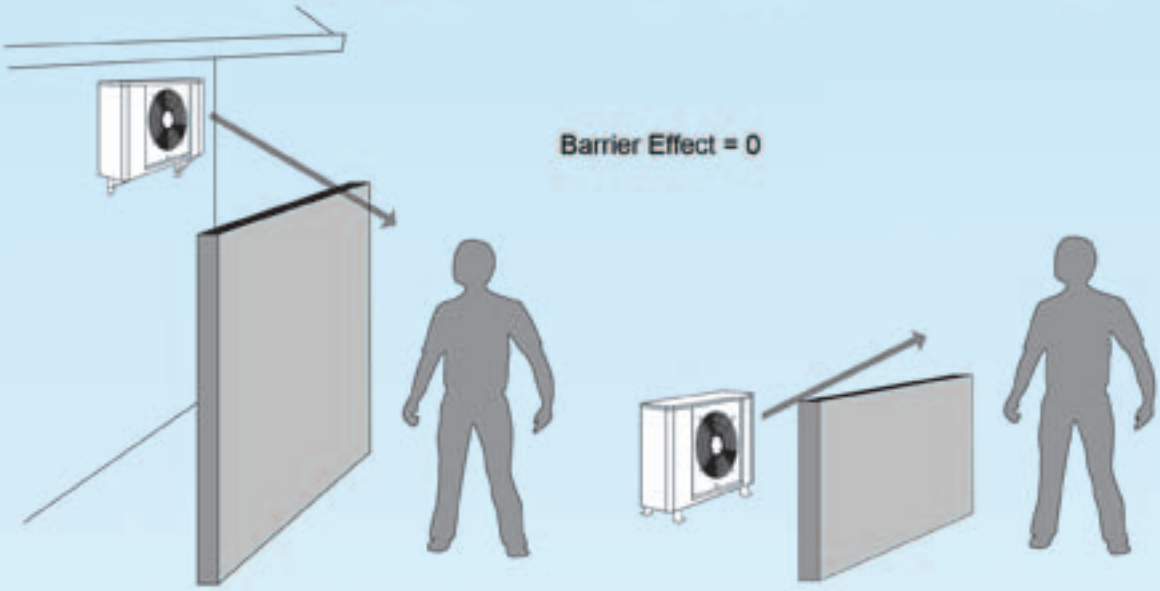
- When units are installed on a lightweight structure or over (or near) a sensitive area, the use of waffle rubber may not be sufficient - consider a double thickness of rubber pads or the use of springs. It is best to obtain professional advice in this situation as the extent of vibration isolation required depends on a number of factors such as the rpm of the equipment, the weight of the equipment, the structure construction etc.

Barriers

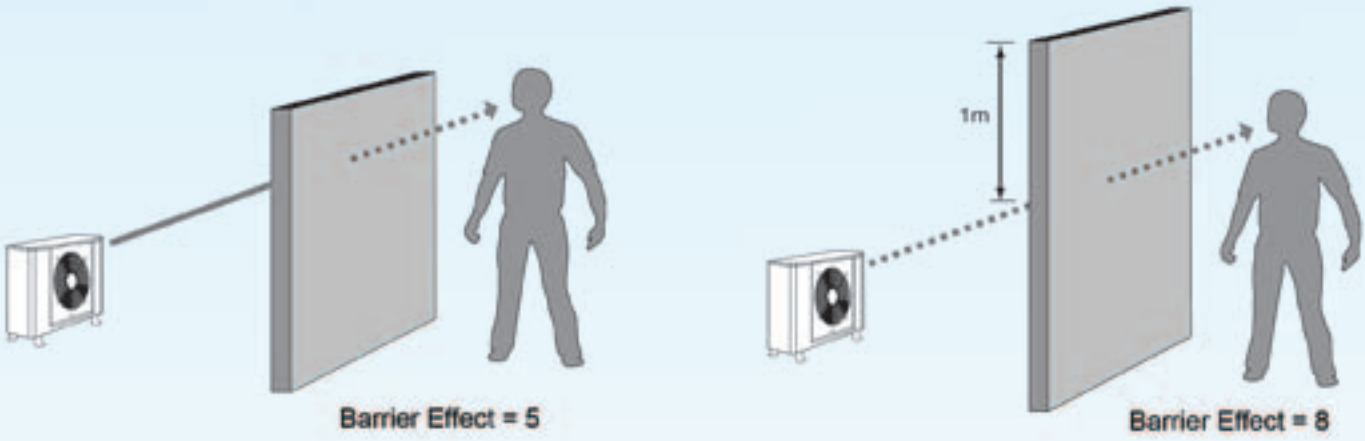
Barriers can be an effective method for reducing noise, however, the barrier must be a solid material with no gaps or penetrations. The material should have a surface density of not less than 5 kg/m^2.

Effective Barriers
Solid timber fence (e.g. double lapped fence)
Solid masonry fence (brick, concrete block, aerated concrete)
Solid colourbond, sheetmetal, or corrugated iron fence
Other solid material (e.g. plywood, cement sheet, particleboard)

Ineffective Barriers
Trees, bushes or shrubs
Fences with holes in them (e.g. missing planks, decorative openings, picket fences, lattices etc.)



A barrier, even an effective barrier, can only work if it screens the noise source from the receiver. If the barrier is too short and the receiver can see the noise source, then the Barrier Effect is insignificant. If the barrier screens the line of sight so the receiver cannot see the noise source then the Barrier Effect is approximately 5 dBA. If the barrier is very high (e.g. higher than 1m above the line of sight) then the Barrier Effect is 8 dBA.



A Guide to Calculating Noise Levels

Step 1 - SWL of Unit
Enter the sound Power Level (SWL) of the proposed equipment at the top of the table.

Step 2 - Distance Factor
Determine the shortest distance between the location of the proposed unit and the receiver position (e.g. neighbour). For simplicity the distance between the unit and the boundary may be acceptable. Circle the corresponding Distance Factor in Column 1.

Step 3 - Barrier Effect
Determine the type of barrier - if any between the proposed unit and the receiver position. Check the section on 'Barriers' to determine the situation you have. Remember that an 'Ineffective Barrier' is one where there is no barrier or the barrier or fence has holes in it which allows the noise to pass through it (e.g. picket fences, missing planks, decorative openings etc.). Circle the corresponding Barrier Factor in Column 2.

Step 4 - Reflection Factor
Determine the number of reflective surfaces that are within 3 metres of the proposed unit, such as walls and large eaves (do not include the ground). Circle the corresponding Reflection Factor in Column 3.

Step 5 - Resultant Noise Level
Determine the estimated Resultant Noise Level by:

Noise Level = SWL of Proposed Unit − Distance Factor − Barrier Effect + Reflection Factor

Sound Power Level (SWL) of Proposed Unit - _____ dBA

Column 1	
Shortest straight line distance from Unit to Receiver position (m)	**Distance Factor**
1	8
2	14
3	17
4	20
5	22
6	23
7	25
8	26
10	28

Column 2	
Barrier	**Barrier Effect**
Ineffective Barrier	0
Effective Barrier	
Line of sight to unit not blocked	0
Blocks line of sight to unit	5
High barrier blocks line of sight of unit by more than 1 m	8

Column 3	
Reflection	**Reflection Factor**
No reflecting surfaces within 3 m	0
One reflecting surface within 3 m (one wall)	3
Two reflecting surfaces within 3 m (two walls)	5
Three reflecting surfaces within 3 m (two walls and large eaves)	6
	6

_____ − _____ − _____ + _____

SWL Distance Factor Barrier Effect Reflection Factor

= Resultant Sound Pressure Level (SPL) _____

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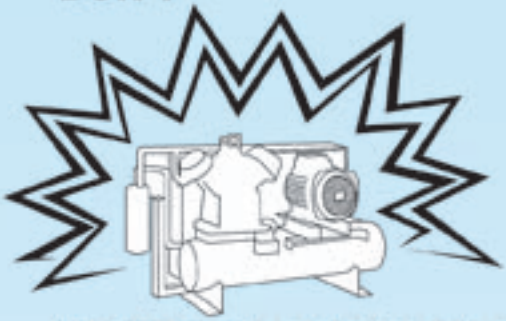
Do's and Don't's

As you can see from the Guide to Calculating Noise Levels, one of the most important factors is the Sound Power Level (SWL) of the proposed unit.

DO

Use the quietest unit to begin with - it may be the difference between an acceptable or unacceptable noise level for a given location.

DON'T

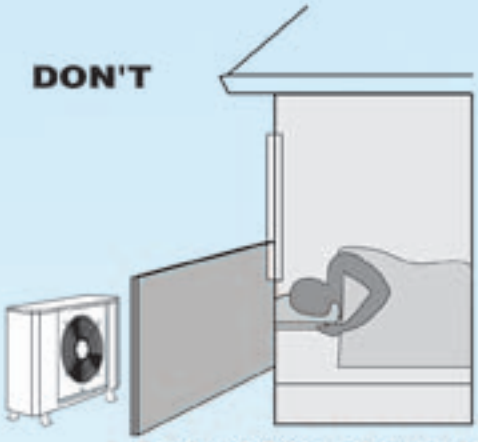


Don't necessarily use the cheapest unit - it may be the noisiest - check the SWL.

DO

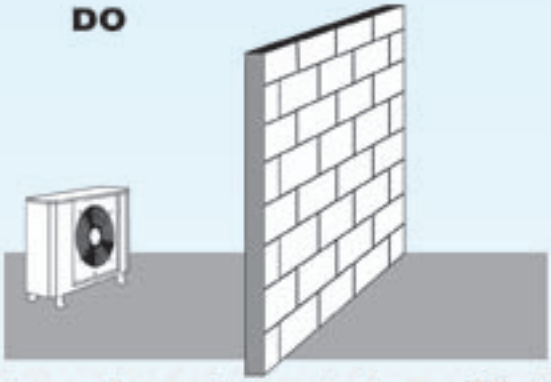
Install the unit as far from the boundary as possible - the further it is from neighbours, the lower the noise level. Place the unit facing the back fence or the furthest fence if possible.

DON'T



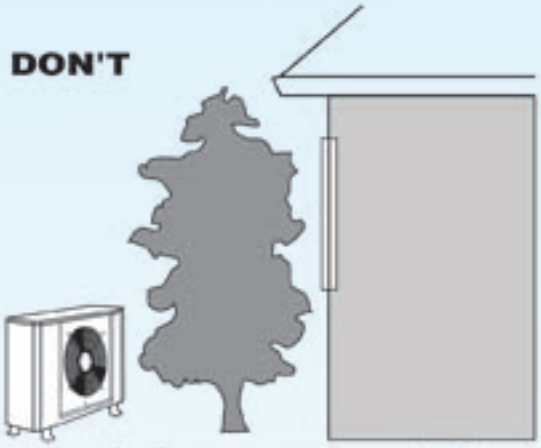
Don't install the unit near a boundary, especially if it is near a window or worst of all - near a bedroom window!

DO



Make sure that any fences or barriers are Effective Barriers, with no holes, gaps or missing planks.

DON'T



Don't assume any tree or bush is an Efffective Barrier - it is not and it won't provide any protection from the noise.

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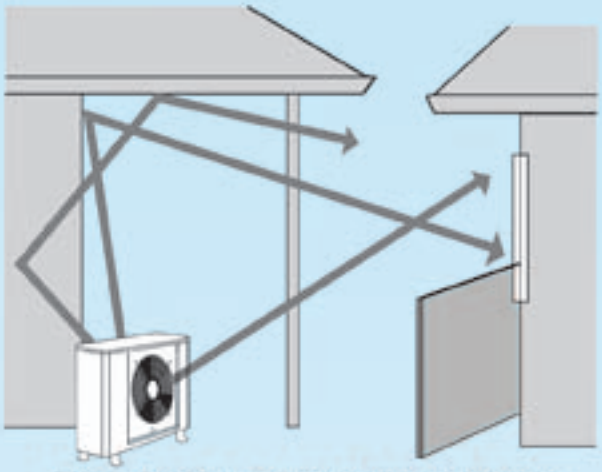
Do's and Don't's

DO

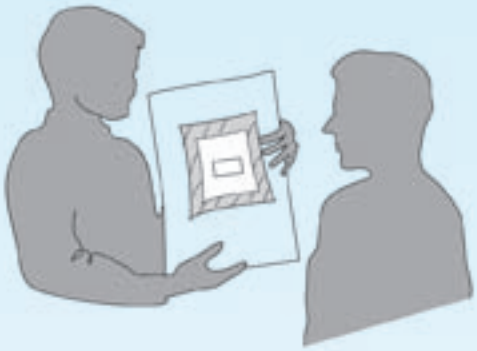
Try and locate the unit away from any reflecting surfaces.

DON'T



Don't place the unit near corners or in very reverberant spaces such as carports or alcoves.

DO



Ask for acoustic advice from a professional qualified acoustic consultant. Even if the expected noise level is too high a consultant will be able to design an enclosure or advise on how to reduce the noise level.

DON'T

Don't assume the problem will go away - it won't. Act now before it is a problem and you will have a happy client, not an ongoing and possibly expensive complaint.

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References

The following Acts, Regulations and Guidelines are applicable for the respective States and Territories, but may not be limited to these.

If a detailed assessment is required or the expected noise level is excessive, you should consult a qualified Acoustic Consultant.

New South Wales:
Protection of the Environment Operations (Noise Control) Regulations 2000 (Section 52)
Noise Control (Miscellaneous Articles) Regulation 1995

Victoria:
Environment Protection (Residential Noise) Regulations 1997

Queensland:
Environment Protection (Noise) Policy 1997
Environment Protection Act 1994
Environment Protection Regulation 1998

South Australia:
Environment Protection (Machine Noise) Policy 1994
Environment Protection Act 1995

Western Australia:
Environment Protection (Noise) Regulations 1997
Environment Protection Act 1986
Noise Abatement (Noise Labeling of Equipment) Regulations (No. 2) 1985

Tasmania:
Environment Protection (Noise) Amendment Regulations 2000, Statutory Rules 2000, No. 186

Australian Capital Territory:
Environment Protection Policy 1998 (Noise)
Environment Protection Act 2000
Environment Protection Regulations 1997

State Head Offices

Victoria & Tasmania 19 King Street **Blackburn** Tel-03 9894 1033 Fax-03 9894 3378

New South Wales & Australian Capital Territory 49 St. Hilliers Road **Auburn** Tel-02 9749 8383 Fax-02 9646 2634

Queensland & Northern Territory 32 Perrin Place **Salisbury** Tel-07 3875 0400 Fax-07 3277 7608

South Australia 142 Richmond Road **Marleston** Tel-08 8234 1191 Fax-08 8234 1402

Western Australia 40 Abernethy Road **Belmont** Tel-08 9277 5922 Fax-08 9277 9729

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